

ACROSS THE ATLANTIC: CABLES VERSUS SATELLITES

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Dominique Verguese and Polen Lloret

ABSTRACT: Forecasts are made for future use and comparative costs of satellite and cable communication. While all judgements are tentative, satellites seem cheaper if used to full extent. Cables will continue to be used to keep up competition in pricing, and for special purposes, i.e., cable TV.

Scarcely 15 years ago the only really "operational" means of communication | /18* available across the North Atlantic was telegraph using submarine cables. Then in 1956 the first commercial transatlantic telephone cable was put into service and allowed 48 simultaneous connections to be made. Afterwards, intercontinental telephone connections developed at an increasing rate close to 20% per year, requiring an improvement in cable technology until the time that a new arrival, the telecommunications satellite, completely overturned the facts of the problem.

Since the launching of the first telecommunications satellite in 1965, severe competition has begun, both on the technological plane and on the commercial and even political plane. This competition is accompanied by a frequent exchange of arguments, especially when people begin to speak of the comparative costs of the two solutions: the transatlantic cable and the stationary satellite.

No matter what their conclusions may be, one fact appears quite clear: the profit margins of the companies using them, whether it be COMSAT or companies using cables, are comfortable enough to permit a tariff war where the intrinsic ability of each process to make a profit is not a decisive factor.

But the battle is not limited to the Atlantic... The two technologies are preparing to meet at the present time in Europe where, at the failure of the Europa-2 rocket, the Old Continent hesitates more than ever to specify the interest it should give to space achievements.

*Numbers in the margin indicate pagination in the foreign text.

BIRTH OF A RIVALRY

Dominique Verguese

The stationary satellite suddenly appeared above the Atlantic in June 1965. The first of its kind, Early Bird provided 240 new telephone lines at once, while all the cables together totaled only 400.

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Even before this launching, numerous studies had been made on satellite possibilities. In addition to telephone or telegraph services, they could relay radio and television programs over tremendous geographic distances, something beyond the reach of cables at that time; it was only necessary to have enough on-board electrical power to increase their capacity to telephone lines and television channels. With an even greater increase in weight they could some day become, around 1980, capable of direct transmission of television programs to individual receivers provided with small antennas. From the time of its appearance the telecommunications satellite promised to be a powerful medium of influence, to say nothing of propaganda.

A Political Trump

The United States were the more tempted to take advantage of these opportunities because they were the first, and still are today, to know how to manufacture and launch stationary satellites. Therefore the commercial breakthrough of telecommunications satellites was supported by an American political offensive. First a commercial firm, COMSAT, was created in 1962 for the purpose of promoting satellite telecommunications. Then, strengthened with their technological monopoly, the United States offered western countries space telecommunication services at an advantageous price. An agreement creating the international INTELSAT organization was signed in 1964 to assure space telecommunication for the western world with the agent being...COMSAT. The agreement has been renewed.

*Numbers in the margin indicate pagination in the foreign text.

Thus the battle between cables and satellites was unequal from the start, since the satellites allowed the Americans to reinforce their international telecommunication control and their political influence throughout the western world. And this control continues to increase. They refuse to sell rockets to European countries anxious to manufacture their own satellites. As long as satellites which do not offer a larger number of lines are not launched, they cause cable laying decisions to be dragged out... This actually removes all economic interest in cables. And, since the United States are the majority stockholders in Intelsat, they force the realization of series of heavier and heavier satellites to meet, and more than meet, world needs. Therefore in January 1961 the first Intelsat-4 satellite was placed above the Atlantic with a provision for 5,000 to 8,000 telephone lines; between now and 1973 there will be another similar satellite above the Atlantic (plus one reserve satellite), another Intelsat-4 satellite above the Pacific (plus a reserve satellite) and a satellite above the Indian Ocean.

These satellites also seem to have aroused new needs: at the end of 1970 4,388 telephone lines were permanently rented on the Intelsat satellites, (against 2,992 the previous year), including 2,762 on the Atlantic, 1,312 on the Pacific and 314 on the Indian Ocean. The satellites also transmitted television programs for 996 hours.

Surprised by this attack, the cable interests took several years to react and it was not until 1970 that a new transatlantic cable, this time providing 825 lines, was laid. This was only the beginning of a counteroffensive. In Europe as in the United States, private and public telecommunication companies defend cables in the name of the diversity of technical media to be used, and there is no doubt now that the cable will survive. The American ATT company, for example, is planning a cable with 3,500 to 4,000 telephone lines.

For its part, the American Hughes Company, which manufactures the Intelsat-4 rockets, is building for Canada satellites intended to relay television and which costs only 7.5 to 8 million dollars instead of 13.5 million dollars, while offering the same capacity as Intelsat-4, weighing 1/3 less, and to be launched by less expensive rockets.

Intelsat must now decide whether the next satellite generation will offer still more lines than Intelsat-4 (15,000, 25,000?) or approximately the same number of lines at less expense.

Under these conditions, what the cable interests would like is to lay an Atlantic cable in 1976, thus before the next generation of Intelsat satellites comes into existence. For, if the decision is put off, what happened three years ago to the 825-line cable will happen to the future 3,500-4,000 lines cable: it will be scarcely desired...

In the future the rivalry between cables and satellites may become sharper. And the cable interests, who have lost the first bout, are undoubtedly preparing their revenge. Ten years from now it is not impossible that the cable may appear more profitable than the satellite. But the political support which the United States gives to the satellite promises to last. Will the dice remain loaded?

LET US PLAY WITH THE FIGURES

Comparing cables and satellites from an economic point of view is a difficult problem... which is not always approached with the necessary calmness.

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Let us take two examples: while a study on simplified bases puts the competitors side by side, the analysis made by the American Office of Telecommunications suggests that cables will have to offer a much larger number of lines than in the past in order to remain competitive.

A Simplified Evaluation

Some idea of the comparable income from cables and satellites during the next five years can be gotten by studying the typical case of connections across the North Atlantic. The satellites in service will be those of Intelsat series-4 (5,000 to 8,000 lines). During the same period a cable of 1,840 lines will appear (CANTAT II).

The cost of material and installation for the cable amounts to about 70 million dollars, or 40,000 dollars per circuit. The cable has a service life of 20 years, therefore depreciating at the rate of 5% per year. To this rate of amortization should be added a current rate of 8% per year (rate of interest on the sum invested) and costs of use and maintenance (about 3% per year). In sum, every year a telephone circuit costs 16% of the investment which it represents, or \$6,000.

Calculation is not so easy for the satellite.

Including development, an Intelsat-4 satellite costs 13 million dollars. The cost of the Atlas Centaur rocket and its launching is about 14 million dollars. As the satellite can handle 5,000 telephone circuits at one time, the installation of a circuit (space part) thus comes to about \$6,000. Since the service life of the satellite is about 7 years, the amortization rate is about 14%. To this must be added, as for the cable, a current rate of 8% per year and use costs (telemeters, adjustments, etc.), difficult to approximate (2 to

3% per year). Therefore the space part of a telephone circuit comes to about 25% of its installation cost, or \$1,500. /

A "standard" earth station, including a single antenna, costs about 3.5 million dollars for its part. In principle it could handle the same number of circuits as the satellite, namely 5,000. The installation cost of the "Earth" part of a circuit (considering two stations, one at end) is thus about \$1,400. The station must be amortized in 10 years (amortization rate of 10% per year) and a current rate of 8% per year must be considered. To this must be added the costs of use and maintenance: 10% per year according to P.T.T. In all, the Earth part of the satellite telephone circuit would cost 28% of its installation price every year, or about \$400.

Therefore by adding the space part and the "earth" part of a satellite telephone circuit, we reach a total approaching \$2,000 per year. This is to be compared to the cost of \$6,000 per year found for a circuit of a 1,840 line cable.

The "satellite" circuit would therefore turn out to be three times less expensive than the "cable" circuit. But in reality the Earth stations have clearly less of a burden, because the requirements are not so great. Thus, the Pleumeur-Bodou station handles only 200 circuits and should not exceed 500 circuits during the next five years. If the calculations are gone over again on this basis, we find that the cost of the "Earth" part of the circuit is considerably higher (on the order of about \$4,000 per year) and that the total costs of the "cable" or "satellite" circuits are quite close. It is true that the station is much more "burdened" on the American side. Therefore the truth is found in the middle.

This first result has only the merit of providing an order of magnitude. At any rate it shows that the net cost of a circuit, whether by cable or by satellite, is nearly ten times less than its selling price to the user: this is what opens the door to a possible tariff war.

But another factor has an influence on the income status of the two systems: an Intelsat-4 satellite can channel in all three or four times more conversations than a 1,840-line cable. Therefore the satellites play the role of "large carriers" in civil aviation, and the cables the role of traditional airplanes.

When a new installation is put into service (cable or satellite), it immediately offers a certain number of lines which are not all used immediately. It is only as time passes and as needs increase that the connection is progressively "burdened." At least two cases can then develop. The connection can be burdened to the limit before being removed from service; this is the most income producing case. But it may also happen that the installation is out of service before having been completely used: there is a poor coordination between the system and the evolution of needs. This second case refers more particularly to the satellite.

The problem of the satellite is that of overpower; its economic profitability consists largely in series launching. Thus a new aspect of the competition appears: for the user administrations and companies is a "head of the family" investment... as long as its life is safe. For its part the satellite is inclined to desire the death of the cable, to "devour" more and more circuits.

(P.L.)

An American Study

The Office of Telecommunications of the White House had to express itself some months ago on the placing of a second transatlantic cable of 825 lines between France and the United States. It was based on an economic study made at the beginning of the year. By two different methods the study had shown that the annual cost of laying a circuit would vary between \$28,000 and \$35,000 to amortize the investment for a 825-line cable; for a satellite of the Intelsat-4 type, providing 2,850 lines, this cost would fall to \$4,000 to \$6,000; for a 3,500-line cable, it would be \$7,000 to \$8,000.

If the satellite is only used at 1/3 capacity and if it were then compared to an 825-line cable assembly providing altogether the same number of lines, it would still be three times more economical, \$9,500 as compared with \$29,000.

On the other hand, a 3,500-line cable would have an income 1/3 greater than that of Intelsat-4 if the latter rented only 3,500 lines.

Two Methods of Comparison

The conclusion seems clear. Threatened by the satellite, the submarine cable will have to offer several thousand lines to become a real competitor. These figures also show clearly that the existing cables provide very expensive circuits, between \$28,000 and \$35,000 for an 825-line cable, which partially explains the very high price of \$64,000 billed by these stations to the user. In addition, COMSAT has always argued that if it were free to rent its circuits directly to the users, it would bill the placing of circuits at a definitely lower price and would thus assure the complete use of its satellites.

The parameters chosen for this comparative economic study are the following. It is presumed that the service life of the cable is 24 years, while the service life of Intelsat-4 satellites is 7 years, and that the life of the stations on Earth is about 14 years. At current costs Intelsat-4 satellites cost 13 million dollars, the rocket and launching another 14 million dollars, and an Earth station 6 million dollars, if it has two antennas 26 m in diameter. It is hypothesized that one out of four satellite launchings is a failure and that one permanent reserve satellite must be kept in orbit. While the cost of managing and maintaining the satellite is low, about 1 million dollars per year, the station costs practically double the price for 24 years (the current rate of money is supposed to be about 10%). For the cables, which require an investment of 86 million for 825-lines and 94 million for 3,500 lines, maintenance cost is also high and more than doubles the value realized in 24 years.

The first method of comparison supposes that during 24 years, the service life of the cable, satellites of the Intelsat-4 type provide the same number of

point to point lines, but that the Earth stations have only a service life of 14 years and that they must be replaced. Then are added the costs of actualized investment, costs of maintenance and management, administrative cost, profits and taxes calculated at the annual rate of 24% of net investments for satellites and of 14% for cables. Finally, a division is made by the number of circuits in order to get the annual cost per circuit.

In the second method, the initial hypotheses are different. The cost of a supplementary circuit which would be installed over the Atlantic in 1980, either by cables or by satellites, is calculated. By this time the first Intelsat-4 satellites placed above the Atlantic would be amortized, as would be certain Earth stations.

(D.V.)

The satellite does not offer the same services as the cable. In addition to being capable of relaying television programs, it can connect various Earth stations at the same time; connections are no longer point to point as with the submarine cable. In addition, as a stationary satellite "sees" 1/3 of the planet, three vehicles distributed around the equator assure total coverage of the planet, even in polar regions.

Up to now the announced service life of satellites has only been 3 and 1/2 years, with 7 years for Intelsat-4, as compared with 20 to 24 years for cables. However, the short service life of satellites allow advantage to be taken of rapid technological progress to achieve at close intervals vehicles which provide cheaper and cheaper circuits. At the end of its life, on the other hand, the cable is penalized by the cost of the circuit which has remained the same since being put into service.

In reality, while the cable can be repaired, the satellite cannot except very rarely (sometimes an antenna or circuit can be released on order from Earth) and its service life is never guaranteed. Four of the 14 satellites launched by Intelsat were disabled before the end of their life. This leads to the necessity of always having a reserve satellite in orbit. In addition, operation of the rockets, even American ones, is never certain: out of 14 shots Intelsat had to register 3 failures. Due precautions being taken, it takes two to three days to replace a defective satellite with a reserve vehicle, three to ten days to repair a cable.

And the future? Cable interests and satellite builders are working to improve their technology. ATT is making preliminary studies on coaxial cables of 10,000 to 15,000 lines, and COMSAT is studying Intelsat-4 satellites modified for 15,000 to 23,000 circuits and new 40,000 to 85,000 circuit vehicles.

Between 1980 and 1990 we will also see the appearance on the market of new terrestrial systems, such as waveguides capable of providing up to

100,000 or 200,000 lines, a necessary capacity when data transmission and videophone are developed. But for the moment the waveguide seems to be expensive.

One limitation of satellite transmission is the result of the fact that the frequency bands allotted to them are limited in breadth, in order to avoid any change of jamming other transmission systems on Earth. On the other hand, a new cable can always use the same frequencies as the previous cable.

For future satellites it will be necessary to find new technical methods of polarizing waves to make the best use of the current bands. Later they will go to higher frequencies; but attenuation of signals by the atmosphere increases as the frequencies mount. In order to reduce the cost of Earth stations, antenna diameter will be reduced. These two requirements imply that the satellite will always radiate more energy. Therefore, it will be heavier and heavier and more expensive.

THE EUROPEAN FIELD OF BATTLE

After becoming a rival of the submarine cable, the satellite in the next decade will wage battle on the continents. Its ambitions? To transmit educational television programs and telephone communications into developing countries, to distribute recreational television programs into industrialized countries, and finally to broadcast them directly to individual sets.

Canada has been the first to call on national television distributing satellites to be launched in 1972. Had it not been for disputes between companies, the Americans would certainly have done so several years ago. In Europe, the European Organization of Space Research has studied the project of a small 200 kg satellite—an Intelsat-4 weighs 750 kg—which would guarantee transmission of Eurovision programs beginning in 1976 (*Le Monde*, 6 November 1971).

But in November 1969 the European Conference of Radio and Telecommunications (C.E.P.T.) stressed that only one much heavier satellite, providing several thousand telephone lines and relaying two television programs at the same time, had any chance of being profitable beginning with 1980. And it would be necessary to use a very high frequency band, one which is not heavily used. C.E.P.T. began a comparative economic study in 1971 between the satellite and terrestrial media—wireless beams and cables.

C.E.P.T. hypothesizes that the satellite will be used for distances greater than 800 km (excluding strictly national trajectories), to handle between 1980 and 1990 one-third—4,300 in 1980 and 14,400 in 1990—or perhaps half—6,450 in 1980 and 21,600 in 1990—of the telephone communications and two Eurovision programs. Because they are difficult to evaluate today, data traffic is not considered in this calculation. The technical characteristics of the satellite are chosen to minimize the cost of the Earth stations which will be provided with antennas 16 m in diameters (instead of the 26 m of today), and equipped with less expensive amplifiers. Depending upon whether the same frequency bands were reused or not on-board the satellite—which would allow the number |

of lines for the same bandwidth to be doubled—one or two operational satellites functioning at the same time would be necessary if one one-third of the traffic passes through the space system. For each operational satellite an emergency vehicle would have to be in orbit. The probability of success of launching is estimated at 0.9 in 1980 if the rocket is American, 0.75 if the rocket is European. Taking account of the seven year service life of the satellite and of its functioning certainty, four to ten satellites must be anticipated, depending on the hypotheses, for the 1980-1990 decade.

Presuming that the European governments would take care of the expense of developing such a satellite (about 750 kg), C.E.P.T. estimates that its unit price would be about 11 million dollars, while the European rocket and its launching would cost about 22.5 million dollars. If such satellites were launched, P.T.T. would put into service one-third of the anticipated terrestrial circuits with a certain amount of staggering in time, and would thus achieve a savings. C.E.P.T. then calculated that the cost of the space system would be /19 from 65 to 110% higher than in extension of corresponding terrestrial networks—139 to 177 million dollars as compared with 84 million dollars.

Such a study, which compares the total cost of a new system to the cost of extending an existing system, cannot help being unfavorable toward the first. This is why the French P.T.T. does not consider preventing the European countries from producing such vehicles. This is not the opinion of British and German radio. The French P.T.T. stress that if the satellites are not produced in time to become operational in 1980, they will rent circuits on future Intelsat satellites around 1977-1978. This would then exclude all use of a European satellite which might be put into service around 1983-1985.

Such 750-kg satellites could also find other uses. In the current state of technology they would be capable of direct broadcasting of television programs to individual receivers on a territory as large as France; or they could distribute the same number of programs to a geographic zone as extensive as Europe if the programs were no longer received by individual antennas but by somewhat larger community antennas; then the signals would be sent to individual receivers by cables for short distances.

O.R.T.F., which will have no more wireless beam frequencies available after the launching of the fifth series anticipated around 1980, has proceeded to a preliminary economic study of the different systems, just as has S.E.M.A. Today the satellite appears to be competitive with terrestrial systems. O.R.T.F. is particularly interested in the extensive geographic coverage provided by the space vehicle. The fact is that cable becomes expensive as soon as isolated and relatively unpopulated regions must be contacted—in mountains for example—and it is better adapted to a "advertising" television of the American type, not very concerned with "marginal" users, than to television conceived as a "public service," which is the case for France.

Whether carried out by cable or satellite, intercontinental telecommunications are among the most profitable for the user companies or administrations.

Present cable circuits are rented at \$5,000 per month to anyone rich enough to allow itself such utilization (a large multinational company, for example). When the circuit is rented "retail" (on the order of \$3. per communications unit), the margin of security is even higher.

In regard to satellites the communication billing amounts tangibly to the same result for the final user since, at any rate, this user is not given the choice of his communication method. But the breakdown of the bill into its elements is different, since it is necessary to separate the Intelsat portion which rents the space portion to the user companies or administrations, which in turn bill the user. Here there is a difference, depending upon whether one is in Europe or in the United States. In Europe, the half-circuit (from the space station toward the satellite) is rented by Intelsat for \$16,000 per year to radio and telecommunication administrations which also have the entire burden of their terrestrial stations. On the American side the half-circuit is rented for about \$40,000 per year to user companies (American Telephone and Telegraph, International Telephone and Telegraph, RCA and Western Electric). In this case Intelsat takes care of the operation of the terrestrial stations. But this fact is far from entirely explaining the difference of \$24,000 per year existing between the tariffs on either side of the Atlantic. It is easy to understand the penchant of American telephone companies for transatlantic cables which provides them with substantial benefits and which they do not have to share with anyone, while the greater part of satellite benefits redound to Intelsat. Indeed, the latter pays substantial dividends to its stockholders (on the order of 14% per year of invested capital) and among its stockholders it is found, for example, A.T.T. which is well known for its position of supporting cables.

This ambivalent situation gives some idea of what the position of A.T.T. and the majority of other user companies can be, including European administrations: maintenance of a "peaceful coexistence" between cables and satellites, the only way of avoiding a tariff war which would harm everyone... except the basic users.

Granting a satellite half-circuit to European administrations has gone from \$20,000 per year in 1969 to \$16,000 at the present time and could later be diminished to \$12,000. Price objectives around \$5,000 per year have even been announced by COMSAT, but they must certainly be accepted with caution. As for the cable interests, they announced that the investment cost of a half-circuit (employable in principle for 20 years) will go from \$60,000 at present to \$20,000 in 1974 and even to \$10,000 in 1976 (3,500-line cable).

Naturally these are only announcements at the present time and, at any rate, the end must be considered. In the immediate future it is simply a question of reducing the cost of a unit of telephone communication with the United States from \$3. to \$2.25. This is still not the competition we have seen in aviation lines across the North Atlantic...

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LINKS IN SERVICE IN THE NORTH ATLANTIC BY 1974.

	Connecting:	Date of start of service	Capacity in telephone circuits	Investment (in millions of dollars)
A. Cables				
TAT-1	Scotland-Nova Scotia (Canada)	Sept. 1956	51	44.9
TAT-2	France-Nova Scotia	Sept. 1959	48	42
Cantat-1	Scotland-Newfoundland (Canada)	Dec. 1961	80	25
Scotice-Icecan	Scotland-Iceland-Newfoundland	1962-1963	24	12
TAT-3	England-New Jersey (USA)	Oct. 1963	141	46.4
TAT-4	France-New Jersey	Sept. 1965	138	46
TAT-5	Spain-Rhode Island (USA)	April 1970	825	87.80
Cantat-2	England-Nova Scotia	Starts 1974	1,840	74
B. Satellites				
Intelsat-3 (F-6)	Multiple access	Jan. 1970	1,200	*12
Intelsat-3 (F-7)	" "	April 1970	1,200	*12
Intelsat-4 (F-1)	" "	Jan. 1971	5,000-8,000	*26.5
Intelsat-4 (F-2)	" "	1972	5,000-8,000	*26.5

*Including launching, not including ground stations.